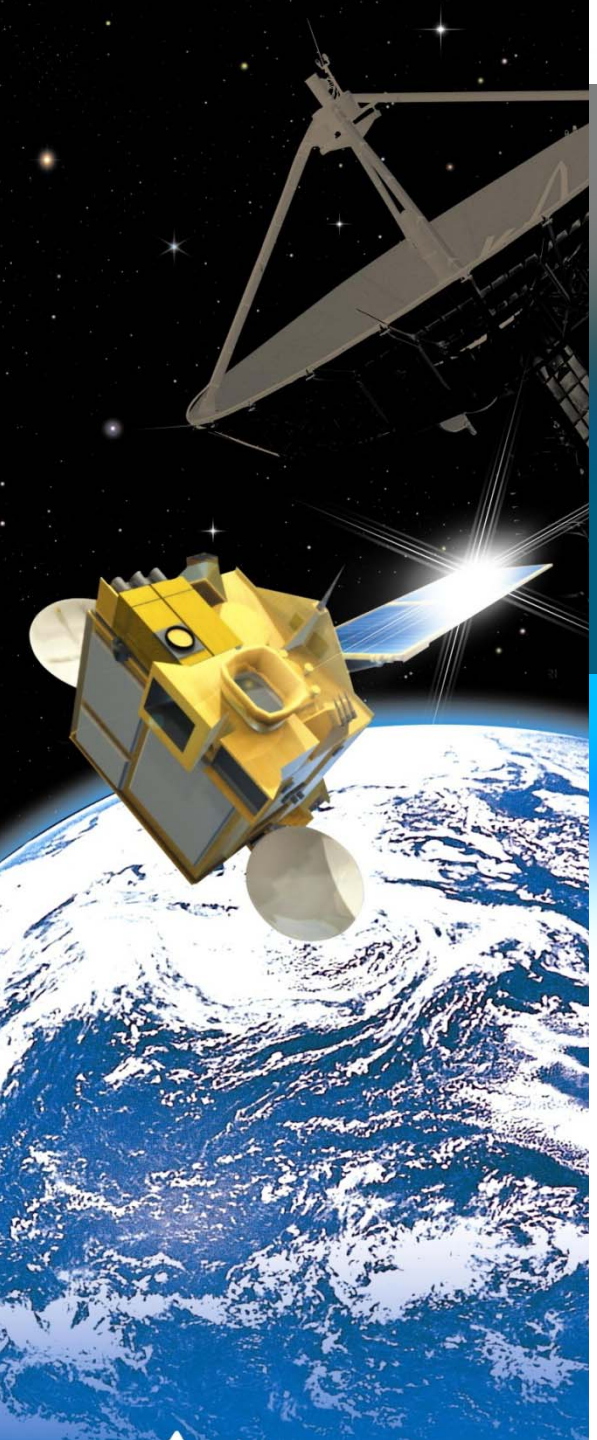


Selection of desert targets for visible channel calibration in the Eastern Hemisphere

Byung-Ju Sohn

Objectives

Calibrating the visible sensors aboard Geostationary satellites located in East Asia (FY, COMS, MTSAT), we need to select common targets from which people and agencies of interest can share the target characteristics and associated information.

The selected target will be recommended to CNES for constructing SADE-type data.

Elements to be considered

1. **Multi-purposes: Sites should be targets commonly shared by at least three satellites in East Asia (FY, COMS, MTSAT).**

   Which targets are commonly seen by three satellites?

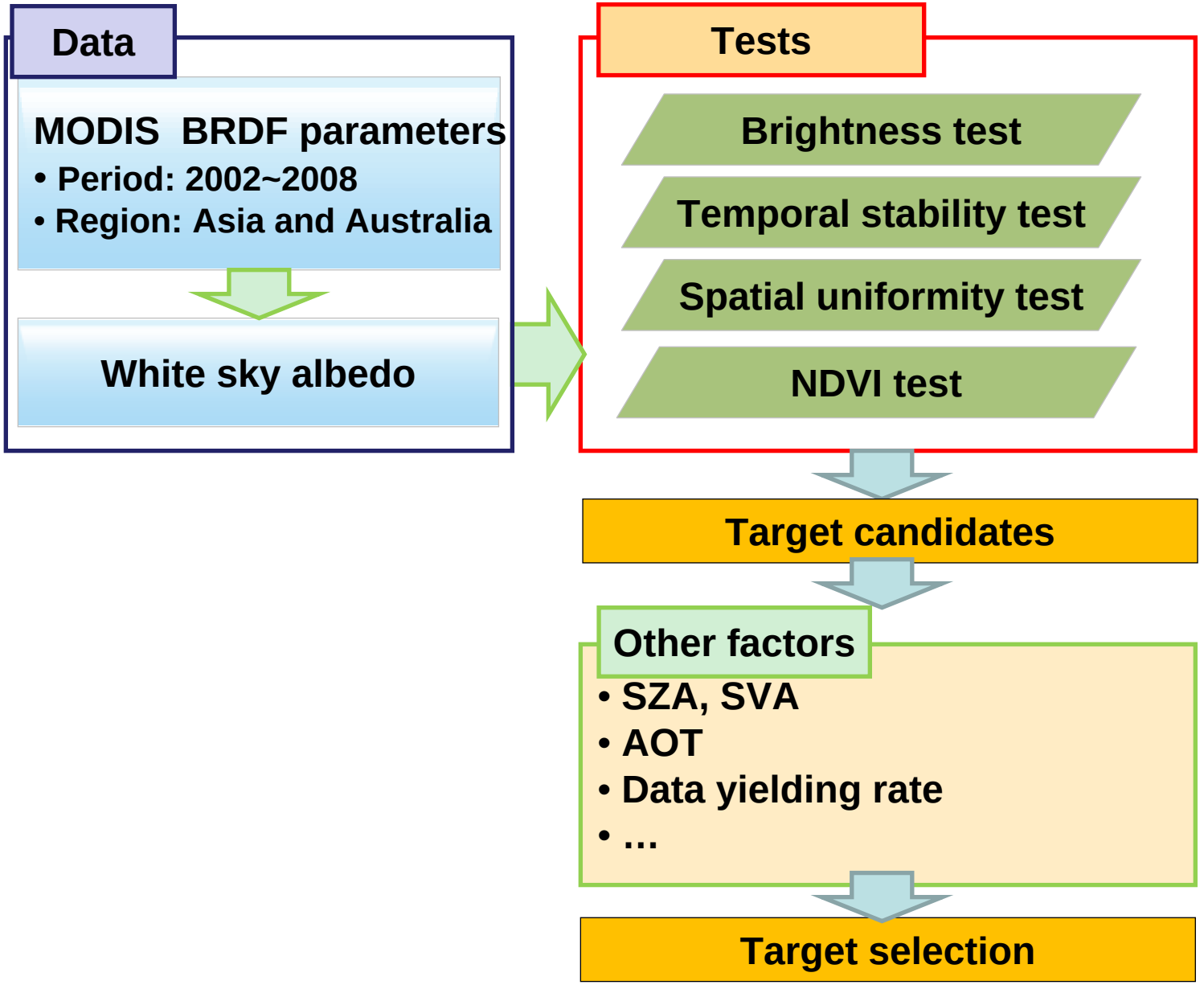
2. **Temporal & spatial stability: vegetation**

3. **Data yielding ratio: low cloudiness, less turbid atmosphere**

4. **High surface reflectance to reduce the atmospheric effect**

5. **Low directional effects: Lower viewing and solar zenith angles to reduce the modeling uncertainties.**

Target selection procedures



Data sets and parameters used

Data: MODIS BRDF parameter

- Resolution: 0.05° X 0.05°
- Frequency: every 8 days
- Period: 2002 ~ 2008
- Products: $f_{iso}(\lambda)$, $f_{vol}(\lambda)$, and $f_{geo}(\lambda)$

Band	Bandwidth (nm)
1	620 - 670
2	841 - 876
3	459 - 479
4	545 - 565
5	1230 - 1250
6	1628 - 1652
7	2105 - 2155

MTSAT-1R (550~900 nm)

COMS (550~800 nm)

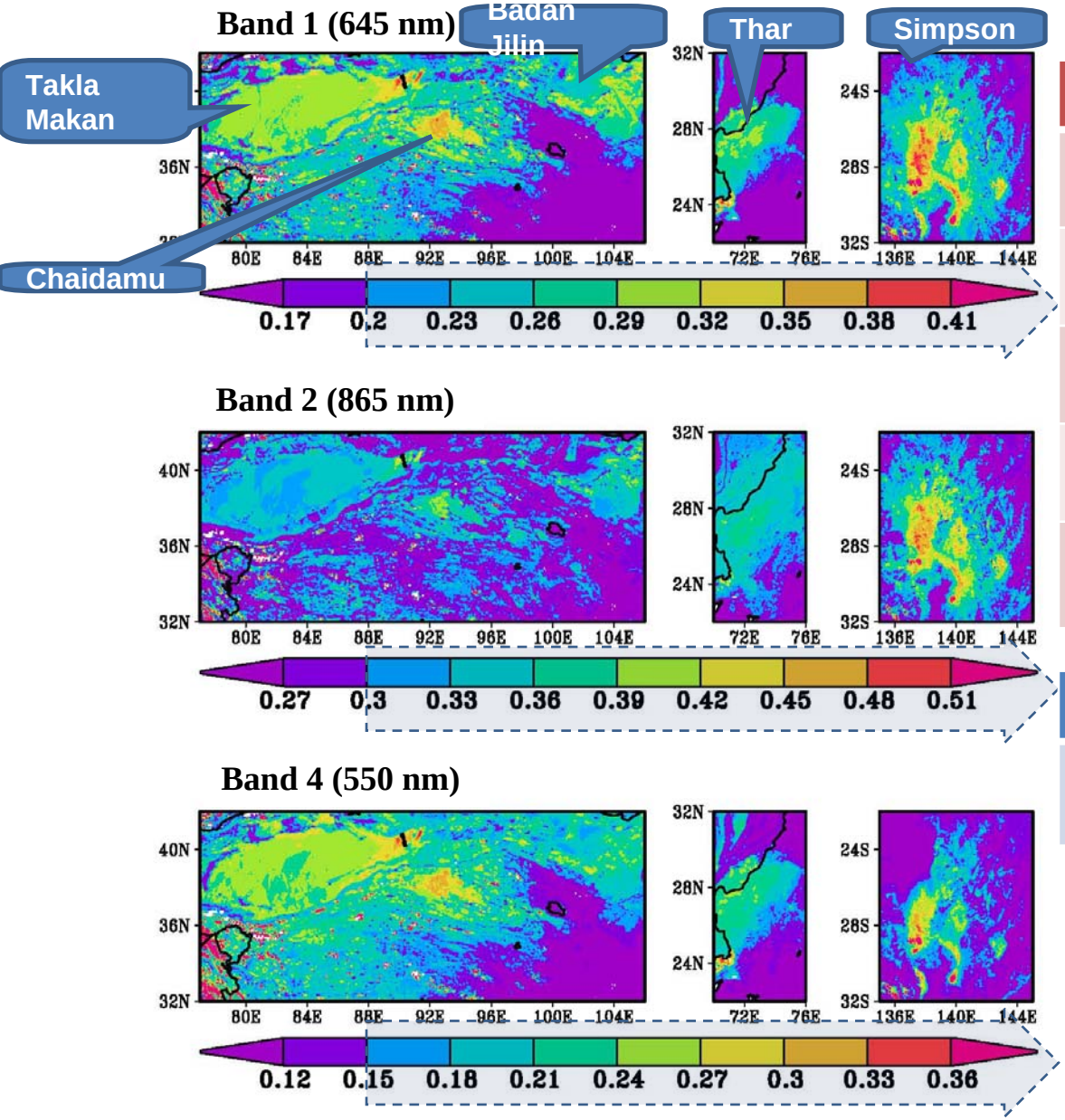
White sky albedo: $\alpha_{ws}(\lambda) = f_{iso}(\lambda) + 0.189184 \times f_{vol}(\lambda) - 1.377622 \times f_{geo}(\lambda)$

Factors for target selection

- Brightness: WSA $\alpha_{ws}(\lambda_i)$ *where* $\lambda_i = band\ 1,\ 2,\ and\ 4$
- Temporal stability: TS $STD^{time}(\alpha_{ws}(\lambda_i)) / AVE^{time}(\alpha_{ws}(\lambda_i))$
- Spatial uniformity: CV $STD^{spatial}(\alpha_{ws}(\lambda_i)) / AVE^{spatial}(\alpha_{ws}(\lambda_i))$

  in a moving 5 X 5 grid (~ 25 X 25 km^2) window
- Spectral stability: NDVI $\dfrac{\alpha_{ws}(\lambda_2) - \alpha_{ws}(\lambda_1)}{\alpha_{ws}(\lambda_2) + \alpha_{ws}(\lambda_1)}$

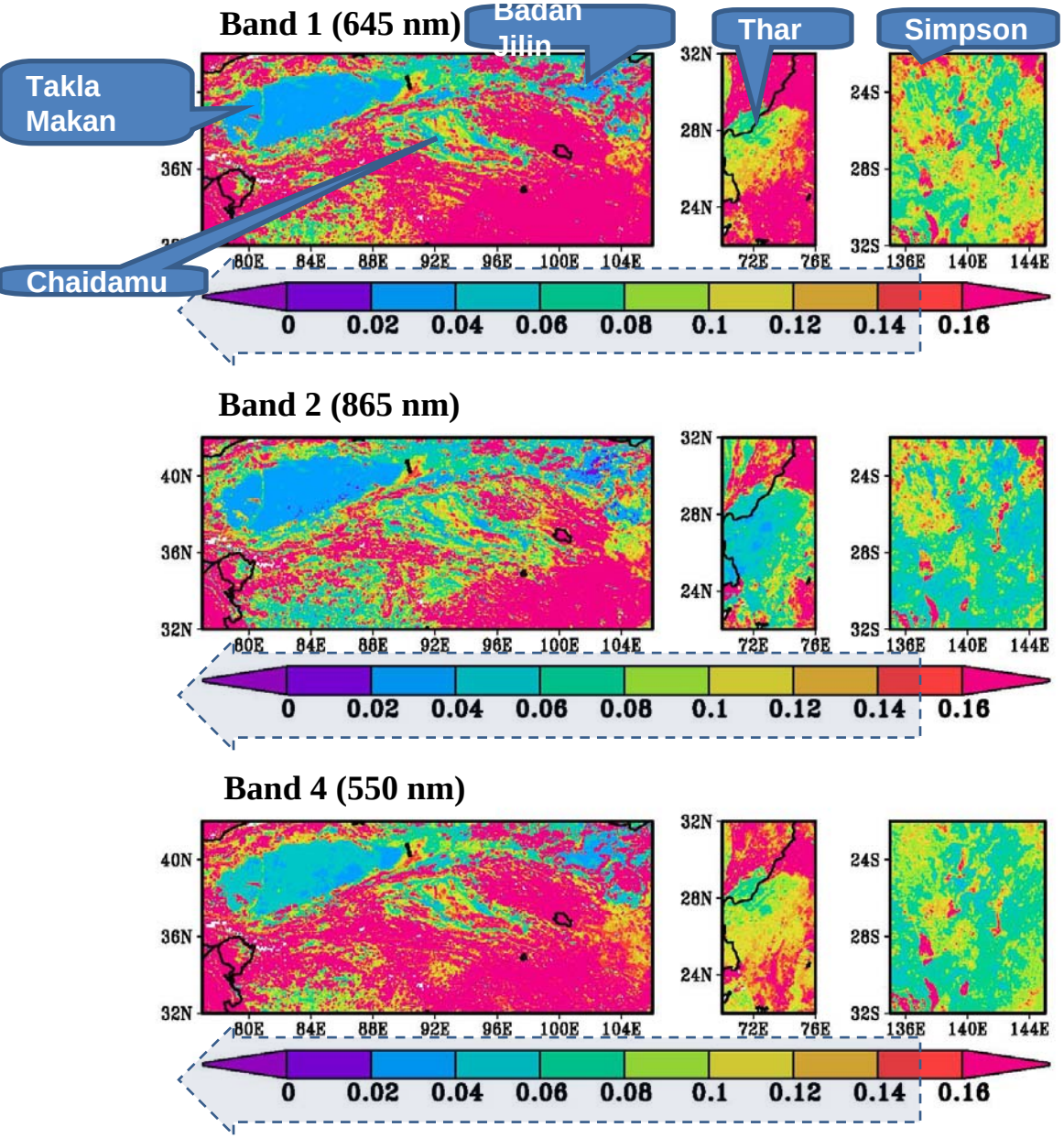
Brightness: white sky albedo (WSA)



Region	Remark
Takla Makan	Bright 0.29 < WSA(645nm) < 0.32
Badan Jilin	Bright 0.26 < WSA(645nm) < 0.32
Chaidamu	Very Bright 0.32 < WSA(645nm) < 0.35
Thar	Bright 0.26 < WSA(645nm)< 0.32
Simpson	Very Bright 0.26 < WSA(645nm) < 0.41

	Weak	Moderate	Strong
WSA (645nm)	**> 0.2**	**> 0.26**	**> 0.30**

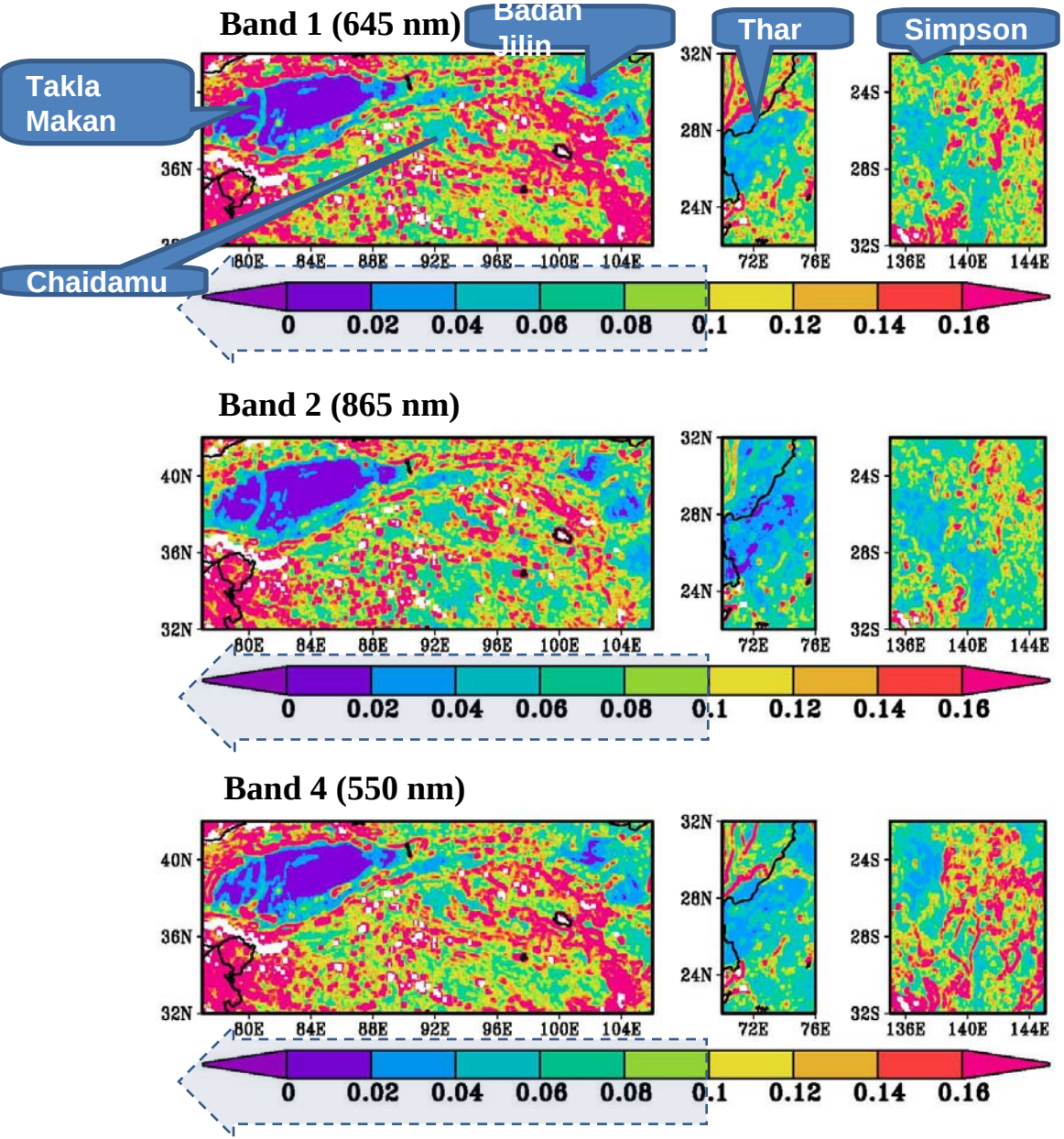
Temporal stability: Normalized temporal standard deviation (TS)



Region	Remark
Takla Makan	Very Stable 0.02 < TS < 0.04
Badan Jilin	Very Stable 0.02 < TS < 0.04
Chaidamu	Very Stable 0.04 < TS < 0.06
Thar	Stable 0.06 < TS < 0.12
Simpson	Stable 0.06 < TS < 0.12

	Weak	Moderate	Strong
TS	**< 0.15**	**< 0.08**	**< 0.06**

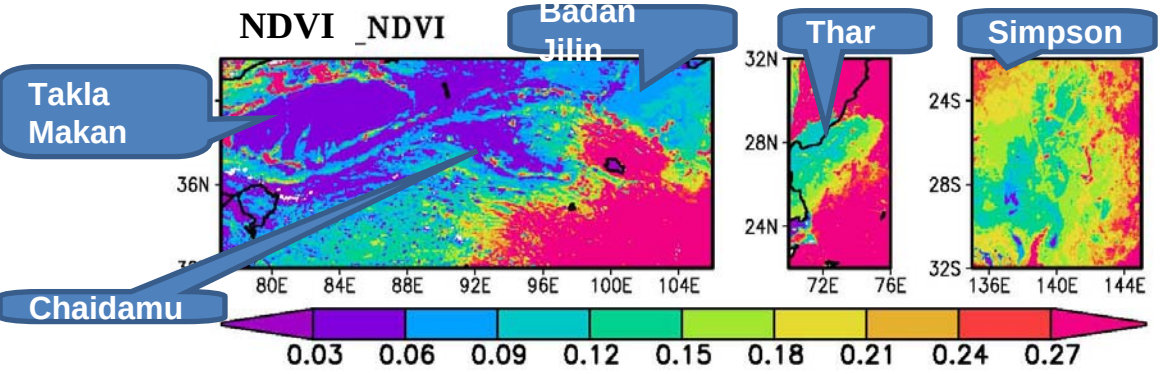
Spatial uniformity: normalized spatial uniformity (CV)

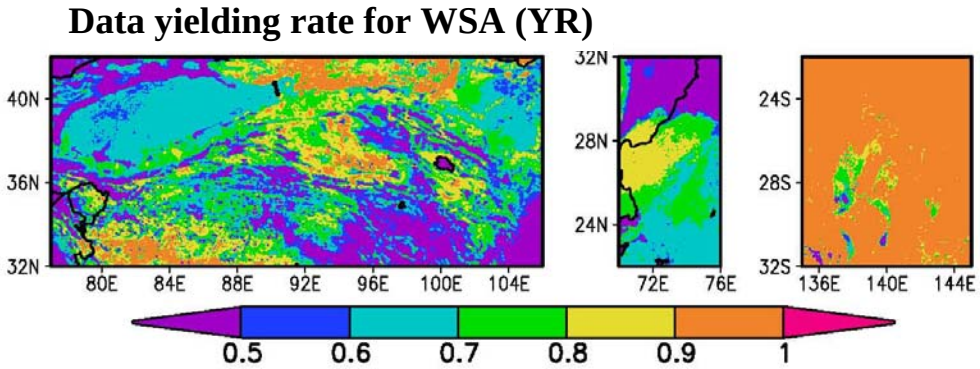


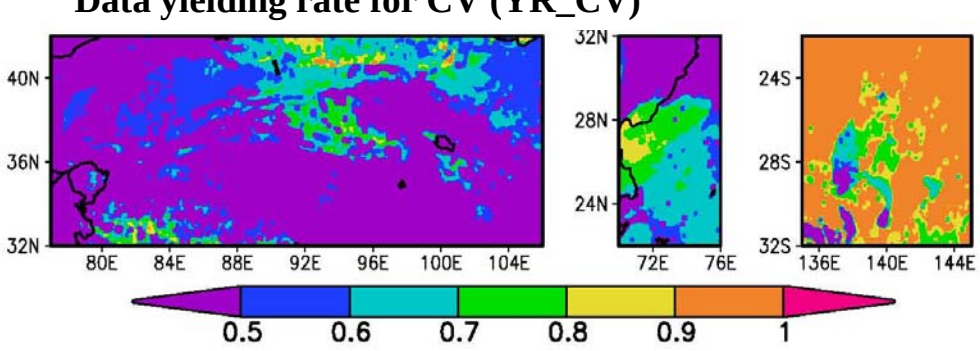
Region	Remark
Takla Makan	Very homogeneous 0 < CV < 0.02
Badan Jilin	Very homogeneous 0 < CV < 0.02
Chaidamu	Homogeneous 0.04 < CV < 0.06
Thar	Homogeneous 0.02 < CV < 0.06
Simpson	Moderately homogeneous 0.04 < CV < 0.08

	Weak	Moderate	Strong
CV	**< 0.1**	**< 0.08**	**< 0.06**

NDVI and YR (data yielding rate)







Region	Remark
Takla Makan	Very low NDVI 0.03 < NDVI < 0.06 Low yielding rate < 60%
Badan Jilin	Low NDVI 0.06 < NDVI < 0.09 Low yielding rate < 60%
Chaidamu	Very low NDVI 0.03 < NDVI < 0.06 High yielding rate: > 80%
Thar	High NDVI 0.12 < NDVI < 0.15 High yielding rate: > 80%
Simpson	High NDVI 0.09 < NDVI < 0.18 High yielding rate: > 80%

	Weak	Moderate	Strong
NDVI	**< 0.25**	**< 0.15**	**< 0.10**

	Weak	Moderate	Strong
YR	**> 0.5**	**> 0.7**	**> 0.8**

Criteria for 6 classes (C1-C6)

	Weak (W)	Moderate (M)	Strong (S)
CV	< 0.1	< 0.08	< 0.06
Aw	> 0.2	> 0.26	> 0.30
Temp	< 0.15	< 0.08	< 0.06
NDVI	< 0.25	< 0.15	< 0.10

	C1	C2	C3	C4	C5	C6
CV	W	M	S	S	S	S
WSA1	W	M	M	S	S	S
TS	W	M	M	M	S	S
NDVI	W	M	M	M	M	S

	C1	C2	C3	C4	C5	C6
CV	< 0.1	< 0.08	< 0.06	< 0.06	< 0.06	< 0.06
WSA1	> 0.2	> 0.26	> 0.26	> 0.30	> 0.30	> 0.30
TS	< 0.15	< 0.08	< 0.08	< 0.08	< 0.06	< 0.06
NDVI	< 0.25	< 0.15	< 0.15	< 0.15	< 0.15	< 0.10

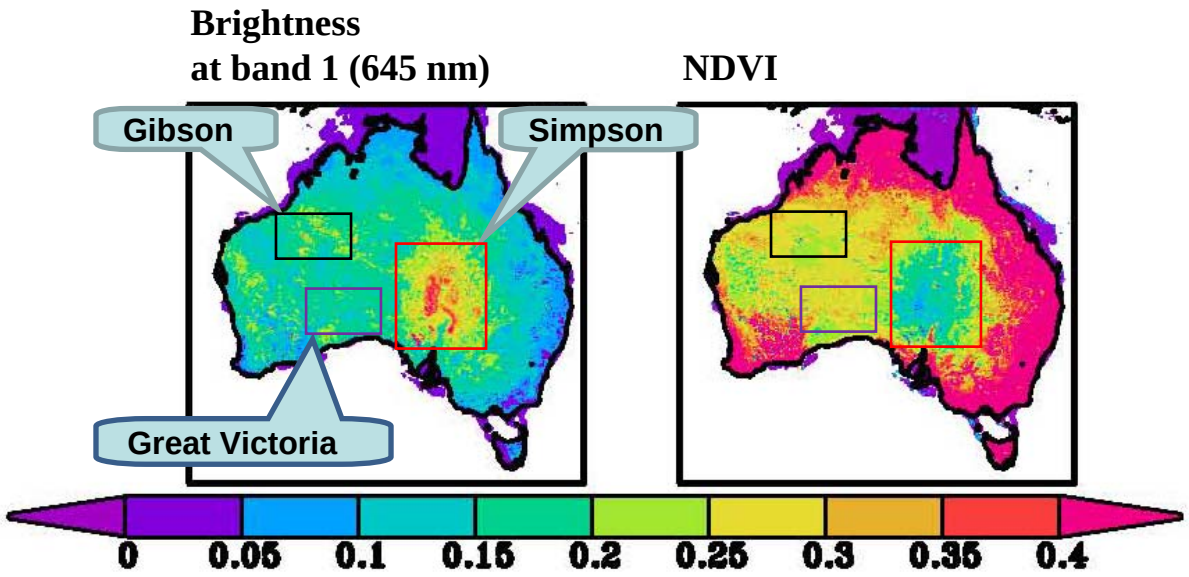
Worse

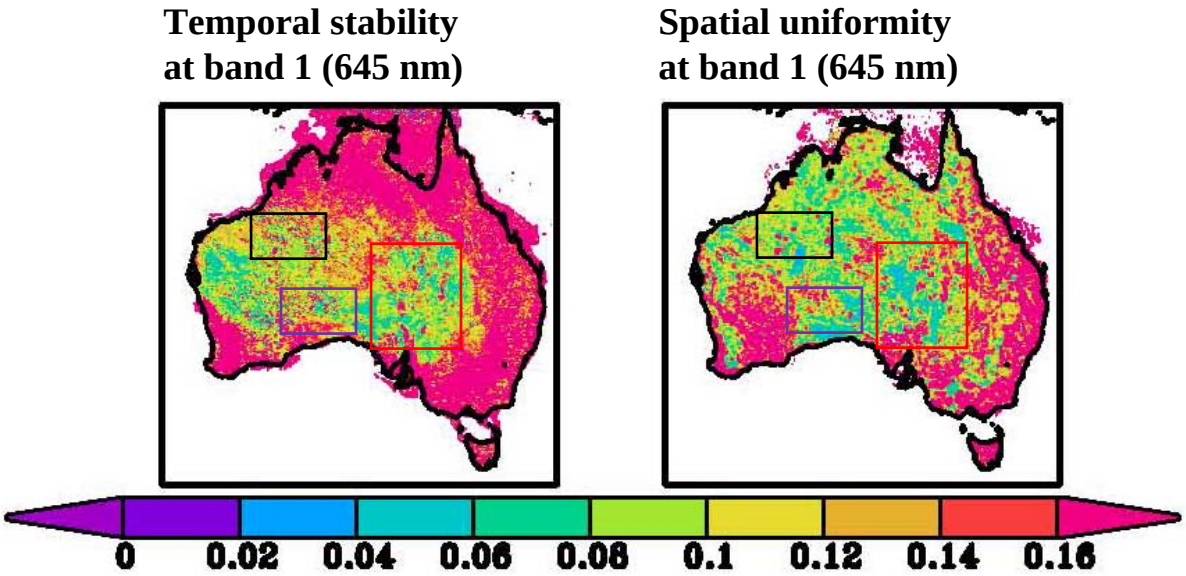
C1

C6

Best

Gibson Desert and Great Victoria Desert

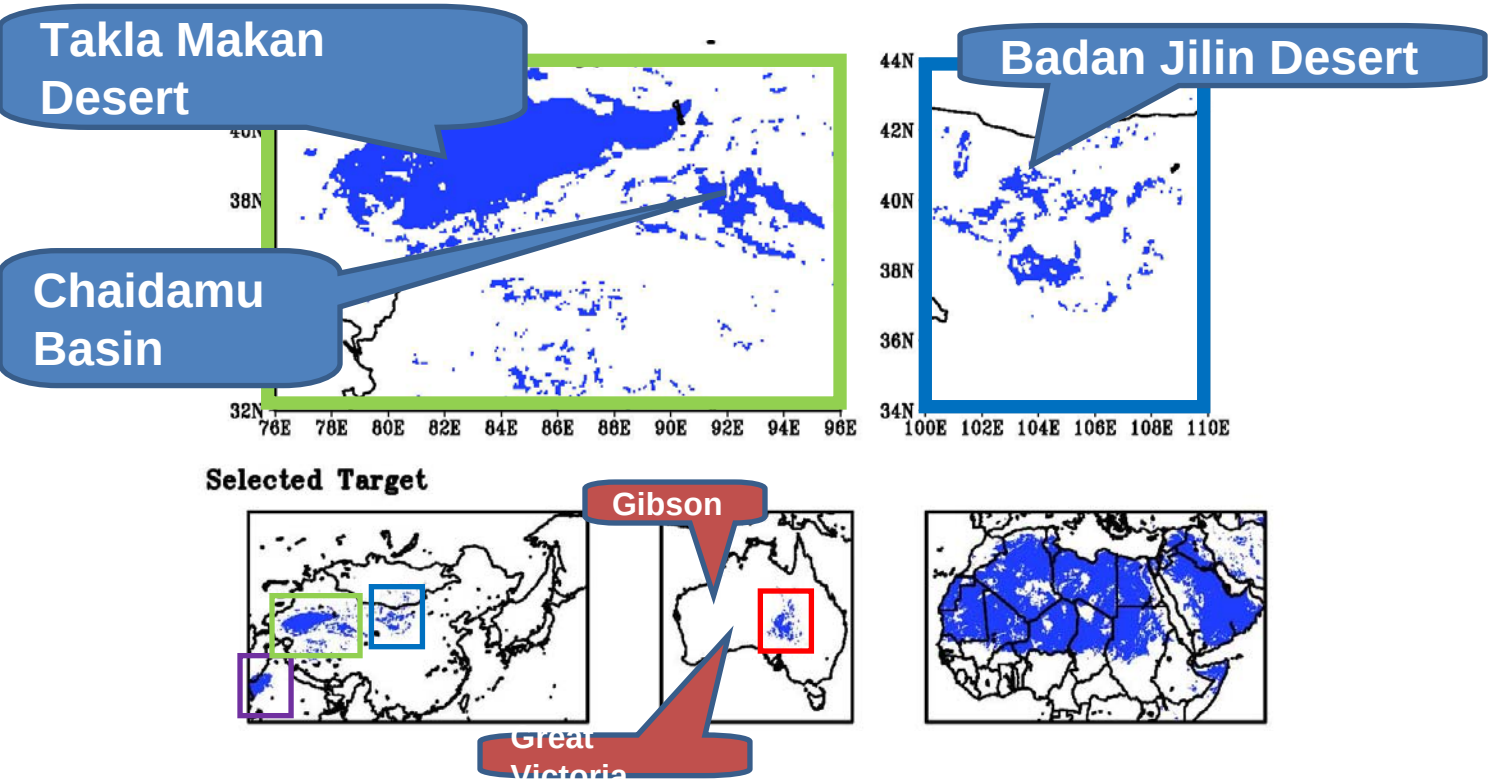




Surface conditions at Gibson desert and Great Victoria desert

-Brightness is relatively low
-NDVI is somewhat larger
-Temporal stability: locally good
-Spatial uniformity: locally good

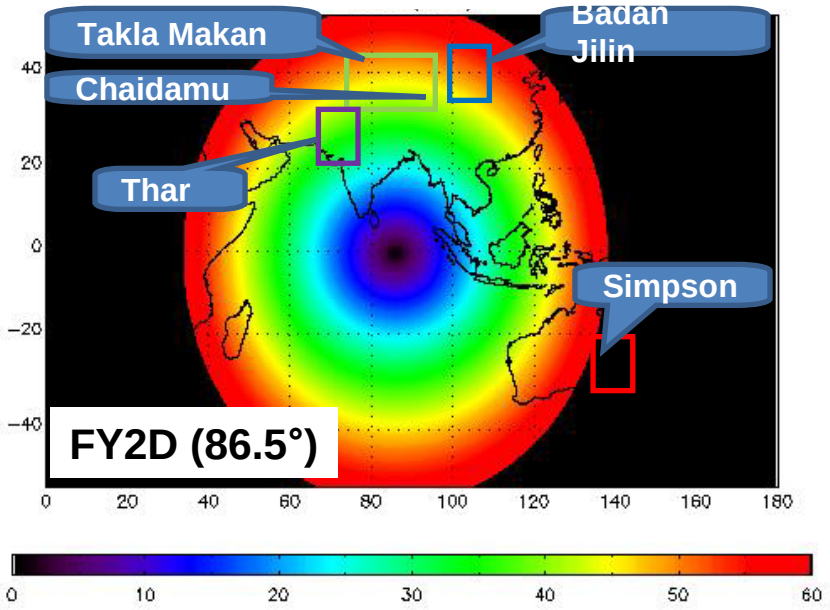
Target candidates

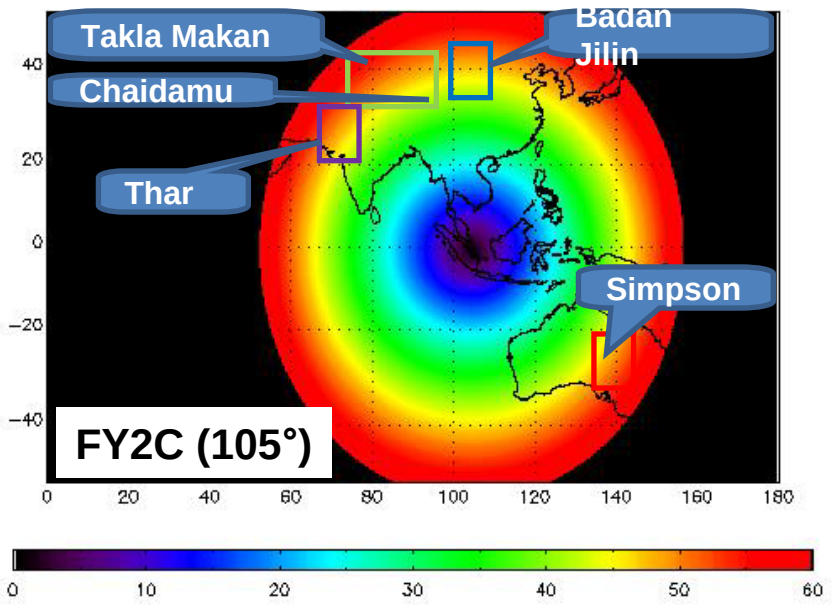


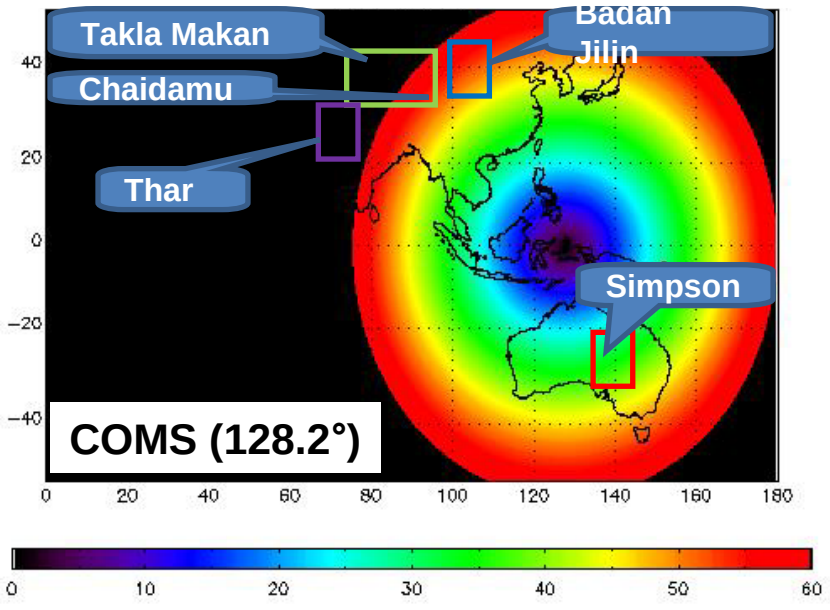
Criteria for target selection

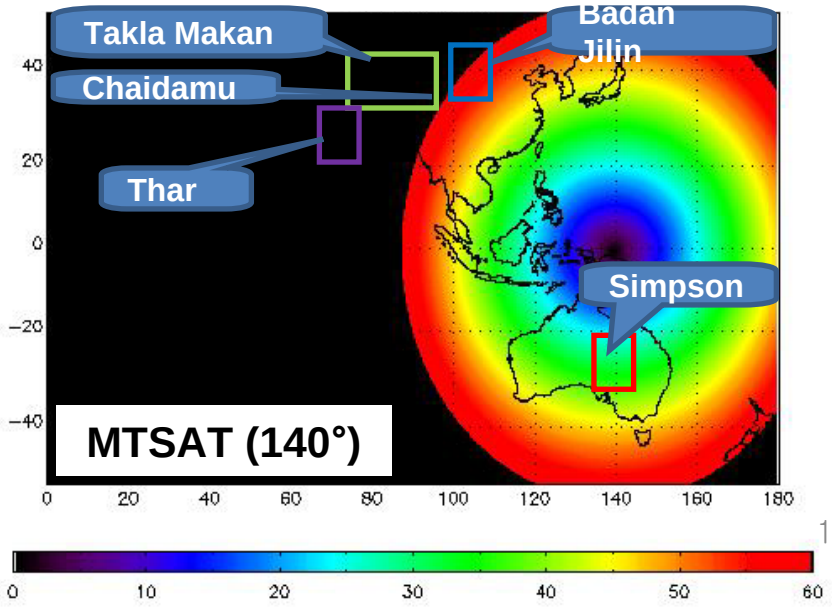
Spatial uniformity at all band < 0.1
Brightness at band 1 > 0.2
Brightness at band 2 > 0.3
Brightness at band 3 > 0.15
Temporal stability at all band < 0.15
NDVI < 0.25

Satellite viewing angles









Solar zenith angles at noon

Site name	Target ID	Latitude (°)	Longitude (°)	Solar zenith angle (°) at noon	
				Summer solstice	Winter solstice
Takla Makan	TAK1	40.025	81.925	16.525	63.525
	TAK2	40.025	84.525	16.525	63.525
	TAK3	40.025	89.025	16.525	63.525
	TAK4	38.025	81.025	14.525	61.525
	TAK5	39.025	84.525	15.525	62.525
Chaidamu	CHA1	37.425	92.075	13.925	60.925
	CHA2	37.725	94.575	14.225	61.225
Badan Jilin	BAD1	40.475	103.375	16.975	63.975
	BAD2	38.025	103.925	14.525	61.525
Thar	THA1	27.775	71.575	4.275	51.275
	THA2	27.275	72.675	3.775	50.775
Simpson	SIM1	-25.225	139.625	48.725	1.725
	SIM2	-27.775	137.275	51.275	4.275
	SIM3	-29.525	137.875	53.025	6.025
	SIM4	-28.825	142.825	52.325	5.325

at (48.3N,105.1W)

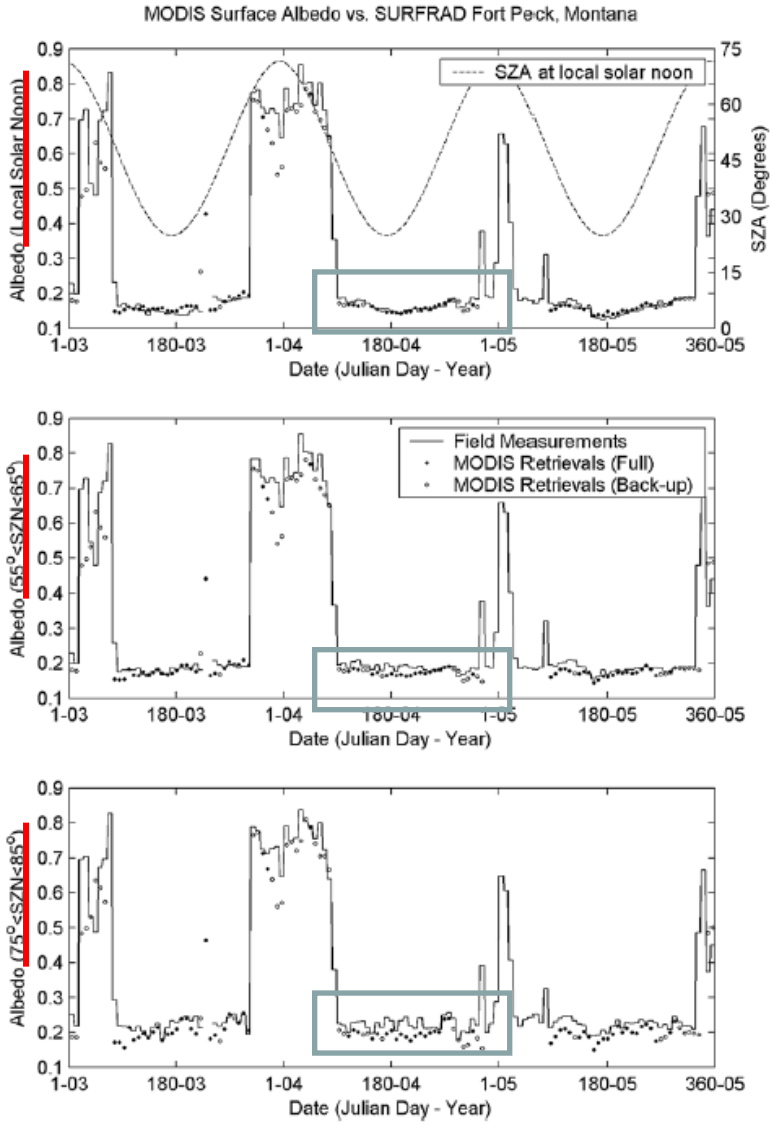


Figure 5. Time series of land surface albedo at three different solar zenith angle (SZN) ranges for the SURFRAD station at Fort Peck, Montana (SURFRAD-FPK), from 2003 to 2005.

Liu et al. (2009, JGR)

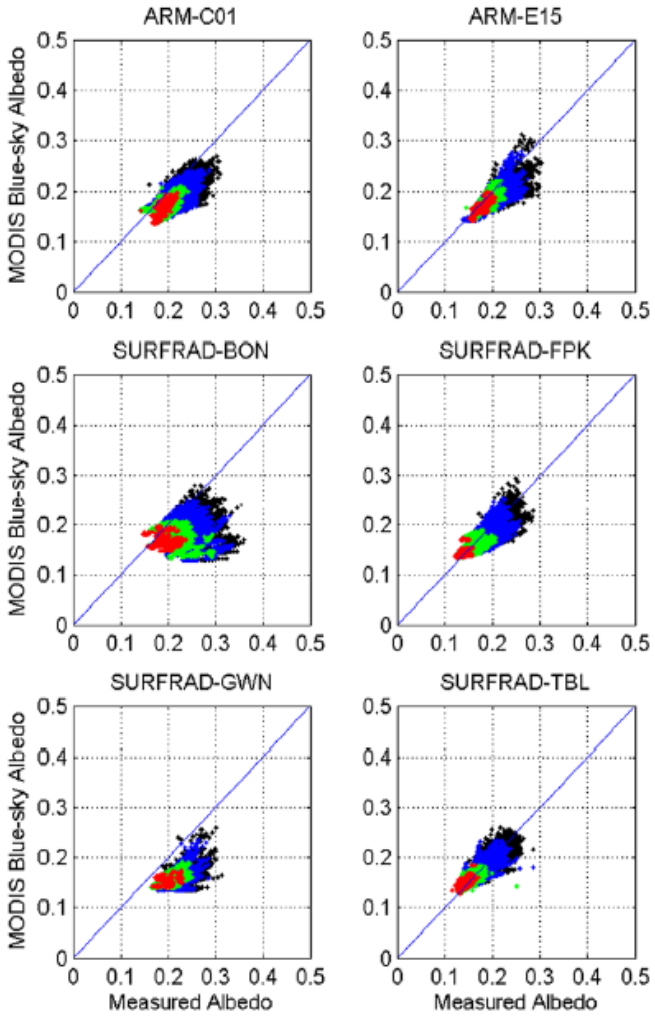
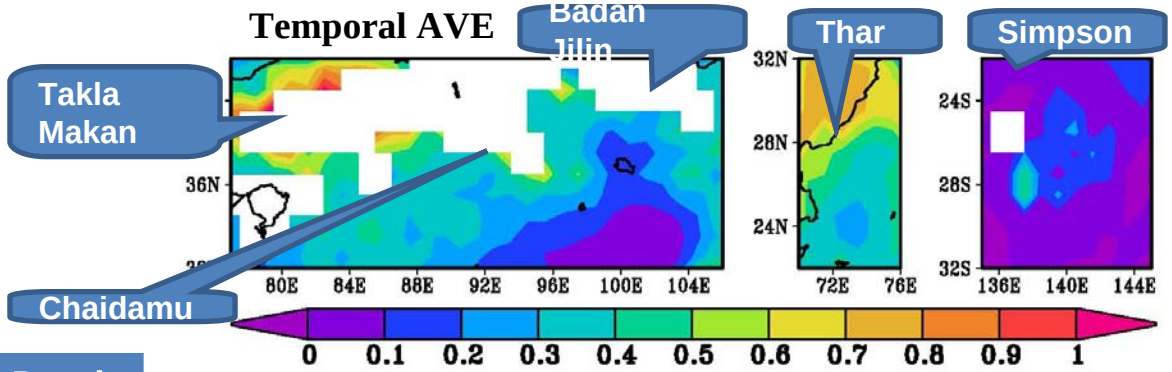


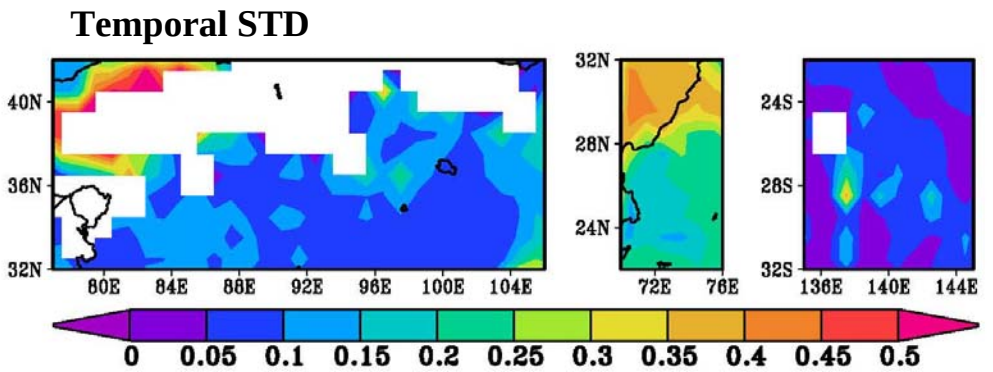
Figure 6. Scatterplots between the ground albedo and the MODIS albedo for all sky conditions and retrievals from both full inversion and the back-up algorithm. Red points are for solar zenith angle of less than 30 degrees; green is for 30 to 50 degrees; blue is for 50 to 70 degrees; and black is for 70 to 90 degrees.

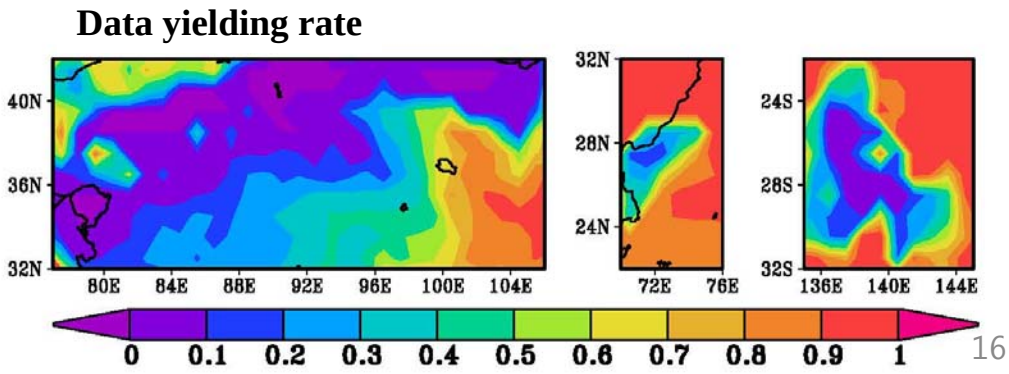
High SZA gives more uncertainty, and SZA<50 is recommended.

Aerosol optical Depth at 550 nm

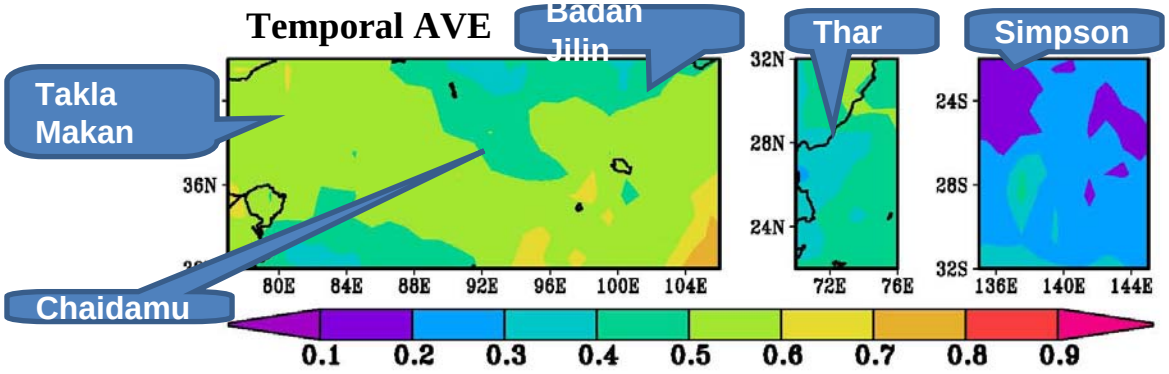
Parameter name	Corrected_Optical_Depth _Land_QA_Mean_Mean
Resolution	1º X 1º
Frequency	8 day
Duration	Jan 2002 ~ Dec 2008
Corrected aerosol optical depth (Land) at 470, 550, and 660 nm: Mean of Level-3 QA Weighted Daily Mean	



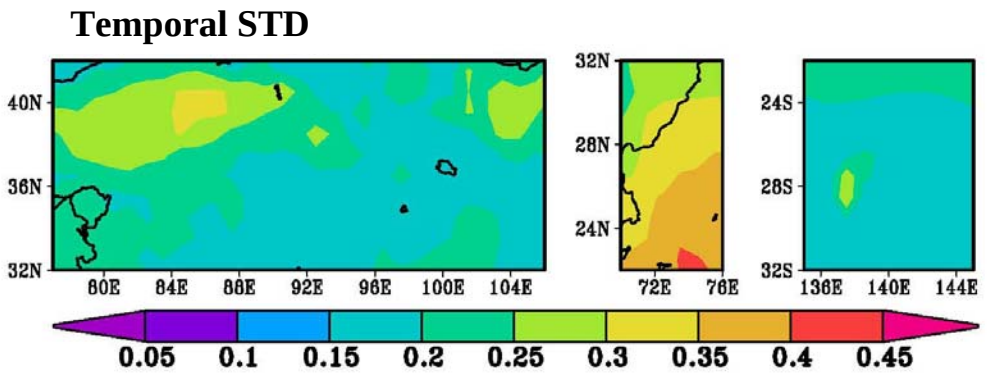




Cloud fraction



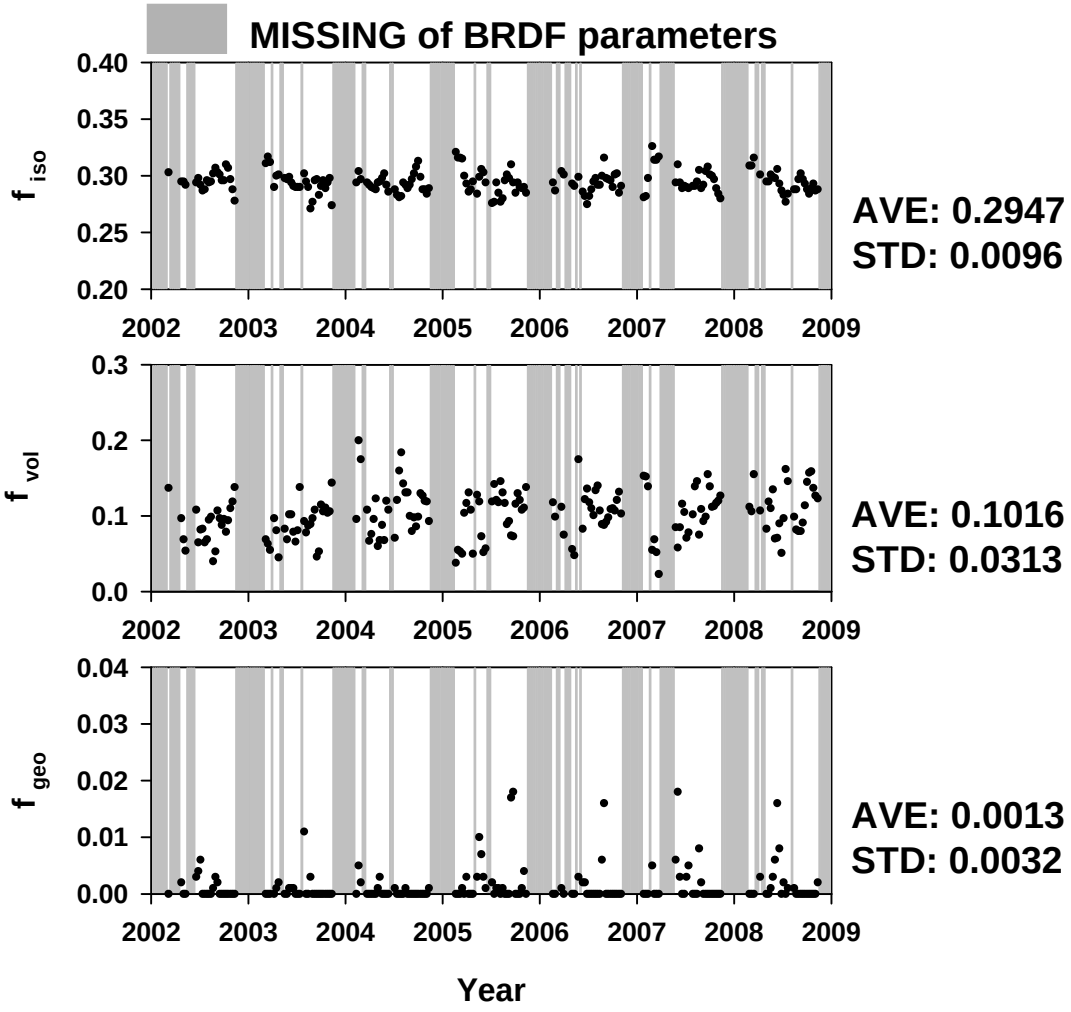
Parameter name	Cloud_Fraction_Day_Mean _Mean
Resolution	1º X 1º
Frequency	8 day
Duration	Jan 2002 ~ Dec 2008
Cloud fraction from cloud mask (count of lowest 2 clear sky confidence levels, cloudy & probably cloudy / total count) Day: Mean of Daily Mean	



Data yielding rate for CLF (YR_CLF)

All data = 1.0

TAK1 in Takla Makan Desert



Target ID	Latitude (°)	Longitude (°)
TAK1	40.025	81.925

Satellite	Location (°)	SVA (°)	SAA (°)
METSAT	74	47.03	192.21
FY2D	86.5	46.55	172.91
FY2C	105	52.06	146.48
COMS	128.2	65.98	121.60
MTSAT	140	74.49	111.84

Summary

Site name	Surface conditions	Data yielding rate	Atm. conditions	Viewing angle	Remarks
Takla Makan Desert	Very good	Low	Bad at winter	-FYD < 50° -FYC 50~60° -COMS, MTSAT > 60°	- Lat. ~40° SZA > 60° in during winter
Badan Jilin Desert	Good	Low	Bad at winter	-FYD, FYC < 50° -COMS, MTSAT 50~60°	
Chaidamu Basin	Good	High	Bad at winter	-FYD, FYC < 50° -COMS 50~60° -MTSAT > 60°	
Thar Desert	Good	High	Bad at summer	-FYD, FYC < 50° -COMS, MTSAT > 60°	Variable NDVI
Simpson Desert	Moderate	High	Partially bad at winter	-FYC, COMS, MTSAT < 50° -FYD > 60°	

Satellite location: FY2D(86.5°), FY2C(105°), COMS(128.2°), MTSAT(140°)

Site candidates

Places commonly shared by three satellites (FY2C, COMS, MTSAT)

1st choice: Austrian Simpson desert
2nd choice: Chaidamu Basin
3rd choice: Taklamakan or Badan Jilin

If we consider only one site commonly used for three satellites, then the site should be in Australian deserts. And it should be the Simpson desert.

Exact location will be provided once the site is determined.